

CONTINUOUS ANGLE RECORDER

Table of Contents

<u>Paragraph</u>	<u>Page</u>
CHAPTER I. INTRODUCTION	
1.1 General	1
1.2 Purpose	1
CHAPTER II. DESCRIPTION	
2.1 Recorder Display	3
2.2 Front Panel Controls	3
2.2.1 ACPower	3
2.2.2 Chart Speed Control	3
2.2.3 Setup Function Controls	4
2.2.4 Channel Position Controls	4
2.2.5 Grid Selection	5
2.2.6 Event Marking	5
2.2.7 Annotation	6
2.2.8 Timer	7
2.3 Chart Paper	7
2.4 Signal Conditioner	7
2.5 Front Panel Controls	8
2.5.1 X100/X1	8
2.5.2 DC/AC	8
2.5.3 RMS/DC	8
2.5.4 FLT	9
2.5.5 OFF/ON	9
2.5.6 VOLTS FULL SCALE	9
2.5.7 VAR OFFSET	9
2.5.8 NOT REF LED	9
2.5.9 VAR GAIN	9

2.6 Source	10
2.7 Input Cable	10

CHAPTER III. RECORDER MAINTENANCE

3.1 General	11
3.2 Initial Inspection	11
3.3 Power Requirements	11
3.4 AC Fuse Replacement	11
3.5 Chassis Ground Connection	11
3.6 Chart Paper Loading	12
3.7 Drive Roller Cleaning	12

CHAPTER IV. FLIGHT RECORD

4.1 General	13
4.2 Start Procedure	13
4.3 Termination	17

CHAPTER V. ANALYSIS OF ANGLE RECORDINGS

5.1 General	19
5.2 Chart Description	19
5.3 Elevation Trace	20
5.4 Rapid Angular Change	20
5.5 Slow Angular Change	20
5.6 Meteorological Data Interference	20
5.7 Limiting Angles	20

5.8 Effect of Radiosonde Movement	20
5.9 Elevation Servo Gain High.	20
5.10 Elevation Servo Gain Low	20
5.11 Azimuth Servo Gain High	20
5.12 Azimuth Servo Gain Low	21
5.13 Elevation Tachometer Gain High	22
5.14 Elevation Tachometer Gain Low	22
5.15 Azimuth Tachometer Gain High	22
5.16 Azimuth Tachometer Gain Low	22
5.17 SystemGainHigh	22
5.18 SystemGainLow	22
5.19 System Phasing	22

List of Illustrations

<u>Figure</u>	<u>Page</u>
5-1 Rapid Angular Change.	3
5-2 Slow Angular Change	24
5-3 Elevation Servo Gain High	25
5-4 Elevation Servo Gain Low	26
5-5 Azimuth Servo Gain High	27
5-6 Azimuth Servo Gain Low	28
5-7 Elevation Tachometer Gain High	29
5-8 Elevation Tachometer Gain Low	30

5-9 Elevation Tachometer Gain Normal	31
5-10 Azimuth Tachometer Gain High	32
5-11 Azimuth Tachometer Gain Low	33
5-12 Azimuth Tachometer Gain Normal	34
5-13 System Gain High	35
5-14 System Gain Low	36
5-15 Incorrect System Phasing	37
5-16 Normal System Phasing	38
Drawing T391 -W1 -SD001 (Angle Recorder Interface Cable)	39

CHAPTER I. INTRODUCTION

1.1 General - This manual contains information on the installation, operation, and maintenance of the Gould EasyGraf recorder and RMS signal conditioners. The recorder is a two channel thermal array recorder equipped with two RMS signal conditioners. The recorder provides a record of the azimuth and elevation 180: 1 synchro transmitter shaft positions, which, through antenna gearing, represent antenna position. Each 180: 1 synchro transmitter provides two 60 Hz voltages representing high resolution angle data to the Synchro/Digital (S/D) processor AI A6 (A17) in the R/ACU. The changing amplitudes of the two voltages correspond sinusoidally to the angle of the antenna. Electrically coupling the recorder to the azimuth and elevation 180: 1 synchro outputs on the AI A6 (A17) card gives an accurate record of antenna movement on the recorder chart.

1.2 Purpose - The recorder gives the NWS electronics technician an accurate and efficient method to test and analyze ART-1/2 radiotheodolite tracking. This will result in improved tracking performance and increased upper air data quality.

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CHAPTER II. DESCRIPTION

2.1 Recorder Display - The recorder prints on prepackaged fan-fold chart paper. Four grid displays are available: no grid, or one, two or four grid areas. The recorder provides two bi-directional event markers and two unidirectional markers (in the two and four grid area types only). Chart annotation comprises chart speed, time and date, signal conditioner status, I.D. (identification) message (a five number character set), and page number.

The recorder also has an internal timer and clock that prints as hours, minutes, seconds, day, month and year. The clock and I.D. message have a battery backup.

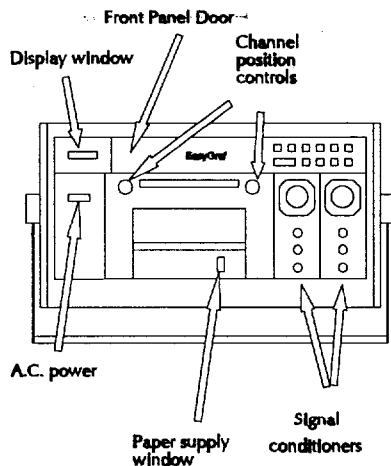


Figure 1

2.2 Front Panel Controls - The front panel, Figure 1, contains controls for input AC power, chart speed and channel waveform positioning. Behind the small panel door, additional controls such as: grid selection, event markers and timer, annotation, time of day, date, and identification (I.D.) message are available to the user.

2.2.1 AC Power - Pushing the power button, located on the left side of the front panel, applies AC power to the recorder and activates all channels and signal conditioner plug-in units.

2.2.2 Chart Speed Control - The upper right side of the front panel, Figure 2, contains all the chart speed controls (1, 5, 10, 25, 50, **100 mm/lsec, divide-by-60, divide-by-100, MARK L, MARK R, and Stop**). The chart speed keys control the speed of the thermal array printer and the printing of the waveforms on paper. Pressing the STOP key with the chart already stopped will form feed one sheet of paper.

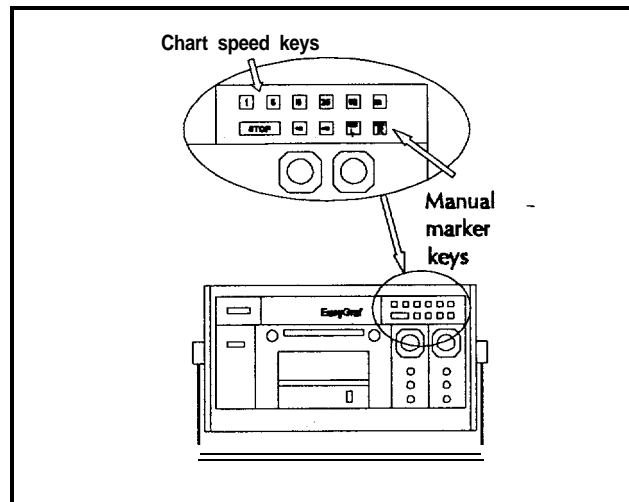


Figure 2

The two divide-by keys, 60 and 100, permit conversion to mm/minute and speed reductions as low as 0.01 mm/set. The divide-by 60 function changes the chart speed to millimeters per minute (printed as "mm/min" on the chart paper). The divide-by 100 function changes the chart speed to hundredths (e.g. 25 mm/sec to 0.25 mm/sec).

The MARK L and MARK R pushbuttons activate manual left and right channel marking. There is a remote stop input on the 15-pin D connector on the back panel of the recorder.

2.2.3 Setup Function Controls - The small panel door located at the top center of the front panel, Figure 3, protects the setup function controls from accidental activation. The setup function controls provide grid selection, event marker display, timing mark display, annotation display, identification (I.D.) message selection, and time/date selection.

The display window, Figure 4, located in the upper left corner of the front panel, displays the I.D. message, time, and date. Two channel position knobs located above the thermal array printer provide waveform positioning. The LED array, located between the channel position knobs, indicates waveform trace position for each active analog channel;

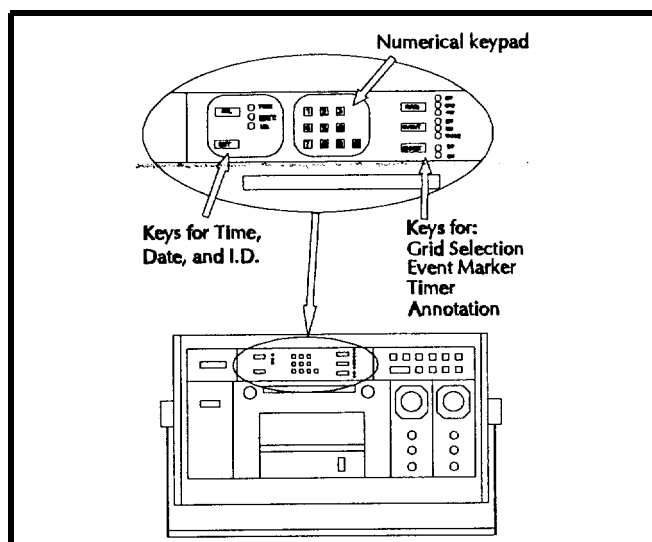


Figure 3

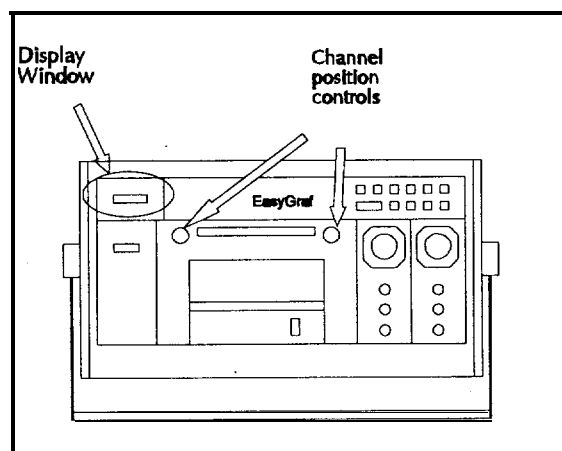


Figure 4

2.2.4 Channel Position Controls - The channel position knobs, located above the thermal array printer, control individual channel printout, waveform positioning, and provide a waveform position lock feature.

To turn either channel printout off, pull the channel position knob of the respective channel out (toward the user). To lock a waveform into position, turn the outer ring of the channel position knob clockwise.

The thermal array printer can also overlap the individual channel waveforms using the inner channel position knobs.

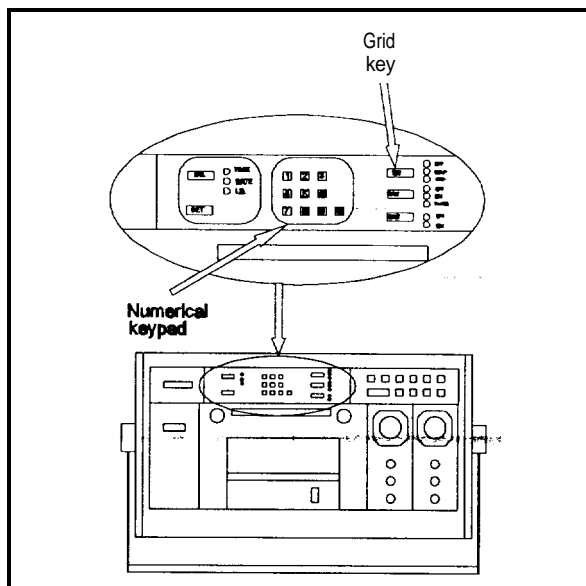


Figure 5

2.2.5 Grid Selection - The recorder will print four grid types. Figure 5 shows the GRID Panel key which is located behind the upper panel door. These GRID panel keys control grid type selection. Three indicators labeled OFF, OVLP, and SEP display the active grid type. Press the GRID panel key until the desired grid type indicator(s) light(s) to select a grid type. Grid type changes can be made on the fly without pressing the STOP key. The chart will hesitate momentarily while changing to the new grid type, then resume speed.

2.2.6 Event Marking - The EVENT key, Figure 6, located behind the upper panel door, enables the event marker inputs and event function. The connections for the event marker inputs are on the rear panel. For more detailed event marker input connection instructions, refer to the installation instructions in Section 2 of the Gould EasyGraf TA240 User's Manual.

Pressing the EVENT key until the EVENT indicator lights activates the event function, which prints an event line on the chart. The recorder records event occurrences on the event line using event markers,

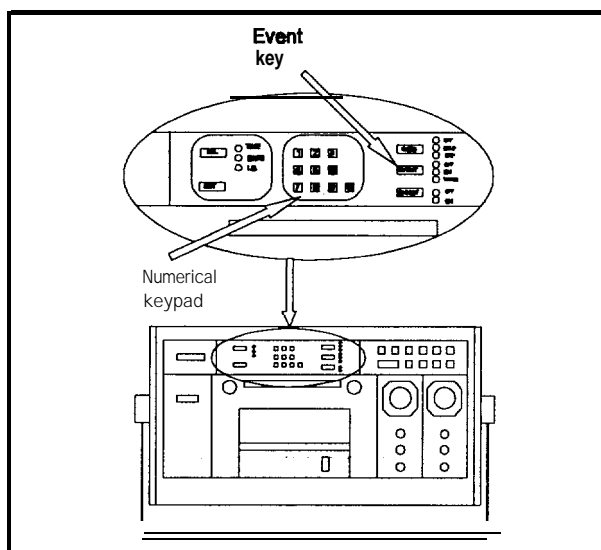


Figure 6

An event marker is a wide vertical bar superimposed on the event line with a length corresponding to the length of the event. To generate an event marker, the recorder must receive either a TTL low or contact closure to ground with a duration of at least one millisecond. When an event of proper duration occurs, the recorder printer marks the event line with an event marker.

The recorder will print up to four event lines, one for each active channel. The event line for channel 1 prints on the left side of the chart. The event line for channel 2 prints on the right side of the chart. Event lines for channels 3 and 4 print in the middle of the chart.

NOTE

The event line for channel 1 is the only event line that prints in overlap mode or with no grid.

The event lines for channels 1 and 2 are bi-directional providing the capability to record two different event occurrences (event marks), one on each side of the event line. Event lines for channels 3 and 4 are unidirectional and record event marks on the left side of the event line only.

In addition to event marker inputs, the recorder provides manual event line marking using the MARK L and MARK R keys located on the right side of the upper panel. The manual event markers print on the channel 1 event line only. With the event function enabled, pressing and holding the MARK L or MARK R key prints an event mark on the respective side of the channel 1 event line. The event mark continues to print until release of the key.

2.2.7 Annotation - Pressing the ANNOT key until the ON indicator lights activates the annotation function as shown in Figure 7. The annotation function comprises chart speed, page number, time, date, channel number, I.D. message, and signal conditioner status. The chart speed and page number print on the left edge of the chart. The time, date, channel number, I.D. message, and signal conditioner status print on the right edge of the chart.

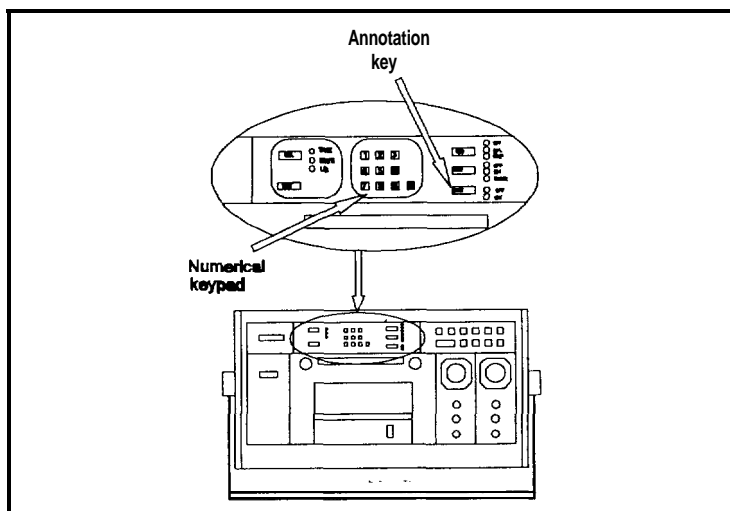


Figure 7

The I.D. message contains a maximum of five numbers and appears in parenthesis after the channel number.

The signal conditioner status comprises the full scale value, mode, filter status, gain and zero suppression, if any. For a more detailed description of signal conditioner status displays, refer to the signal conditioner user's manual.

2.2.8 Timer - Pressing the EVENT key until the TIMER indicator lights activates the timer function. The timer function prints time marks on the right edge of the chart paper. For chart speeds of 1 mm per second or higher, the time marks print at 1 second intervals. For chart speeds lower than 1 mm per second, the time marks print at 1 minute intervals.

2.3 Chart Paper - The recorder uses prepackaged fan-fold chart paper (Gould part number CL-213688). The chart paper is 45 meters (148 feet) in length, 120 millimeters (4.75 inches) in width, and contains 300 sheets. The paper supply window located on the front door of the thermal array printer provides an approximate indication of paper usage.

NOTE

Opening and closing the paper compartment door with the recorder power on will reset the page number to “300”. To avoid lost data due to an incorrect page count display, always check the paper supply through the paper supply window.

2.4 Signal Conditioner - The RMS signal conditioner can measure DC/RMS signals ranging from 0.05 to 500 volts full scale. Features include: zero suppression (DC offset), sensitivity adjustment, AC/DC coupling, and input-to-output isolation. The RMS signal conditioner has a bandwidth of 10 kHz. The recorder uses two 6600 series RMS signal conditioner plug-in modules, Model 13-66 15-20 or 13-6615-20S. The recorder can use any combination of these modules. The operation and features of both are essentially the same.

2.5 Front Panel Controls - The following paragraphs describe the functions and parameters of the signal conditioner front panel controls depicted in Figure 8.

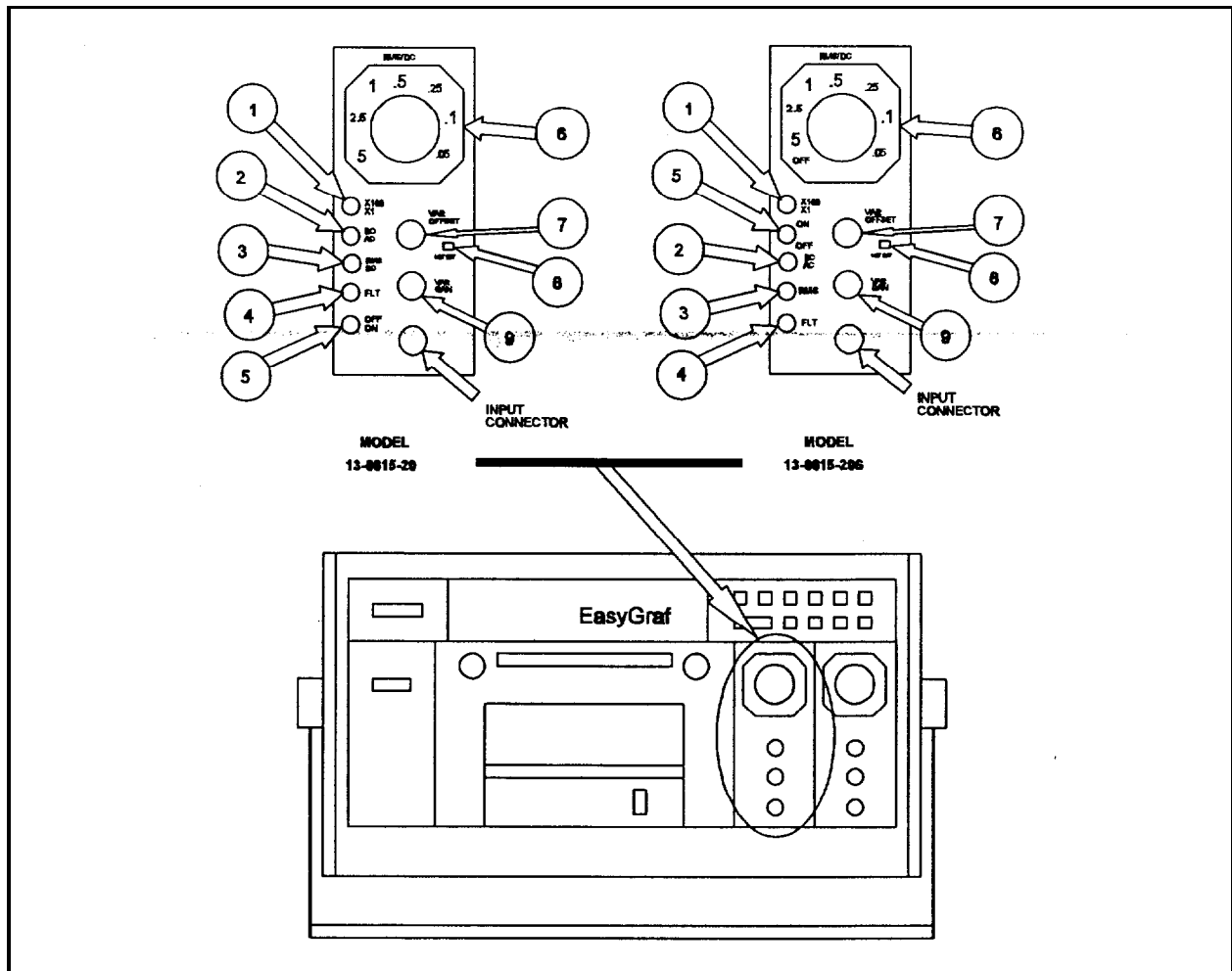


Figure 8

2.5.1 X100/X1 - (Circle 1) This button determines whether the input full scale measurement values are as shown on the VOLTS FULL SCALE knob (X1) or multiplied by 100 (X100). In the X100 mode, the signal conditioner measures inputs between 5 and 500 volts RMS.

2.5.2 DC/AC - (Circle 2) This button controls the input coupling. When the button is out, the input is AC coupled.

2.5.3 RMS/DC - (Circle 3) This button controls the display output. The DC position displays a DC voltage output equivalent to the RMS value of the input. At low frequencies, the DC output may appear unfiltered. When this button is out, the output is a direct representation of the input.

2.5.4 FLT - (Circle 4) This button controls the activation of a 20 Hz, 30 dB/octave low pass filter. When the button is IN, the filter is active.

2.5.5 OFF/ON - (Circle 5) This button controls two different functions depending on the signal conditioner model.

Model 13-6615-20: On this model, the OFF/ON button controls the signal conditioner power. With this button out, the signal conditioner output is on.

Model 13-6615-20S: On this model, the OFF/ON button activates the turns-counter dial on the VAR OFFSET knob. Press the button in to activate the counter dial.

2.5.6 VOLTS FULL SCALE - (Circle 6) The VOLTS FULL SCALE knob sets the input values, Pressing the X100/X1 button in (circle 1) multiplies the VOLTS FULL SCALE knob values by 100 (i.e.: 5 volts to 500 volts). For Model 13-6615-20S the VOLTS FULL SCALE knob also turns the signal conditioner power on/off.

2.5.7 VAR OFFSET - (Circle 7) The VAR OFFSET knob adjusts the zero suppression of the signal conditioner. Zero Suppression suppresses the static component of a signal for greater resolution of the dynamic part of the signal. The model 13-66 15-20 conditioner has uncalibrated variable offset and model 13-6615-20S has calibrated variable offset. Deactivating zero suppression calibrates all readings to standard VOLTS FULL SCALE knob settings.

Model 13-6615-20: To apply offset, pull the VAR OFFSET knob out and turn the knob to set the trace to the desired chart position. (Activating zero suppression lights, the “NOT REF” LED).

Model 13-6615-20S: To apply offset, press the ON/OFF button (circle 5) in to activate the turns-counter dial (Activating zero suppression lights the “NOT REF” LED). The dial selects the percentage of 5 volts full scale offset applied to the signal. Setting the offset to 10.0 suppresses a voltage equal to 100% of 5 volts (500 volts in the X100 setting). Setting the offset to 5.0 suppresses a voltage equal to 50% of 5 volts or 2.5 volts (250 volts in the X100 setting). (Activating zero suppression lights, the “NOT REF” LED).

2.5.8 NOT REF LED - (Circle 8) The NOT REF LED lights when the VAR OFFSET or VAR GAIN controls are active.

2.5.9 VAR GAIN - (Circle 9) The VAR GAIN knob increases the gain applied to the signal conditioner from 1 to 2.5 times for any range from 50 mV to 500 volts full scale. Pressing the knob in turns the variable gain control off and calibrates all readings to standard VOLTS FULL SCALE knob settings. To set the gain between standard settings, pull the VAR GAIN knob out and turn to the desired setting. (Activating variable gain lights the “NOT REF” LED.)

2.6 Source - The recorder and RMS signal conditioners are standard, commercially available items. The manufacturer supplies an instruction manual and parts list with each recorder.

2.7 Input Cable - One input cable connects the recorder to the azimuth and elevation synchro outputs of the ART-1/2 systems.

The input cable is a 25 foot, 5-conductor cable, terminated with two connectors on the recorder side and one connector on the R/ACU side. See NWS Drawing T391 -W 1 -SD00 1 T391-W1-SD001 for connector part numbers and pin connections. This cable connects the 0 to 90 volt RMS 60 Hz outputs of the ART-1/2 azimuth and elevation 180: 1 synchro S2 and S3 windings to the RMS signal conditioner inputs of the recorder. The same S2 and S3 winding outputs are sent to the S/D converter for calculation and display of the azimuth and elevation angles. During antenna movement, the changing amplitudes of the S2 and S3 synchro winding outputs correspond to the angle of the pedestal. Antenna gearing produces one revolution of the 180: 1 synchro for every two degrees of antenna movement, i.e., 180 synchro revolutions for every one revolution of the pedestal or elevation housing.

With continuous antenna movement the 180: 1 synchro produces a sine wave output on the recorder chart. One sweep across the chart equals one-half degree of antenna movement in the respective axis.

CHAPTER III. RECORDER MAINTENANCE

3.1 General - The paragraphs in this chapter describe AC power and recorder grounding requirements. This chapter also has procedures for AC fuse replacement, chart paper loading and drive roller cleaning.

3.2 Initial Inspection - Before making any electrical connections or attempting operation, visually examine the system for broken or loose panels, dented or nicked panels, and broken, chipped, or missing connectors at the rear of the recorder.

3.3 Power Requirements - The recorder can operate on any of the following AC voltages (50/60 Hertz): 100/120/220/240 volts +/-10%. The recorder is preset for 120 VAC.

3.4 AC Fuse Replacement



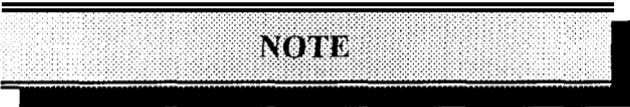
DISCONNECT THE POWER CORD BEFORE REPLACING THE AC POWER FUSE.

To change the fuse, gain access to the power input module on the rear of the recorder. The recorder has a hole in the side of the case for screwdriver access to the lip of the module door. To access the fuse, pry the module door open with a small flat blade screwdriver. Remove the fuse from the fuse cartridge in the module and replace it with a 4 amp, 250 volt time delay metric fuse (5 mm diameter by 20 mm length). Install the fuse in the cartridge and insert the cartridge in the lower compartment of the module. Installing the fuse cartridge in the upper compartment of the module renders the recorder inoperable.

Plug the female end of the AC power cord into the power input module. Plug the male end into an AC outlet. The recorder is now ready for power application.

3.5 Chassis Ground Connection - The recorder has a chassis ground terminal on the rear panel of the recorder. Connect this terminal to a reliable earth ground connection to provide user shock protection and reduce noise interference.

3.6 Chart Paper Loading



NOTE

**LOAD THE CHART PAPER WITH THE RECORDER
POWER ON TO RESET THE PAGE COUNTER TO PAGE
NUMBER 300.**

1. Grasp the handle in the door of the printer and pull the door out allowing it to open completely.
2. Place the stack of chart paper, treated (shiny) side up, into the paper compartment with the black square on the sheets in the lower left-hand corner of the stack. The black square indicates the printing side of the chart paper. The red line on the side of the paper represents the end of the paper and should be toward the bottom.
3. Pull the top edge of the first sheet of paper out until it is even with the top edge of the door. The paper will cover the paper guides.
4. Close the door. The printer will automatically feed two to three pages of paper through the slot under the roller, out the printer door, and stop. The printer is now ready for operation.

3.7 Drive Roller Cleaning - In time, paper dust may accumulate on the drive roller. This will make paper loading difficult. Use the following procedure to clean the paper dust from the drive roller.

1. Grasp the handle in the door of the printer and pull the door out allowing it to open completely.
2. Remove the paper from the paper compartment.
3. Wipe the visible surface of the roller with a lint-free tissue or a tissue saturated, but not dripping, with alcohol solvent. Use a low water content solution: 90% either reagent grade denatured ethanol or isopropyl alcohol. Rotate the roller with your finger tips to expose the entire surface.
4. Remove any excess liquid by wiping with a dry lint-free tissue.
5. Allow the roller to air dry completely before reloading paper.

CHAPTER IV. FLIGHT RECORD

4.1 General - This section has instructions for obtaining a continuous angle recording of the radiosonde observation. The recorder only needs a few steps to start and operate. Use the directions below to install and operate the recorder.

CAUTION

DO NOT ATTEMPT TO MAKE A RECORDING IF CONDITIONS INDICATE THAT THE ANTENNA MAY MAKE SEVERAL REVOLUTIONS DURING A FLIGHT. THIS WILL USUALLY OCCUR DURING A LOW WIND, OVERHEAD FLIGHT.

4.2 Start Procedure

OFFICE

1. Press the recorder POWER button to apply AC power to the recorder. The recorder will display the current time in the display window located on the upper left side of the front panel.

NOTE

If an error code (e.g. "E 0001") appears on the display window after power-up, refer to Appendix B in the Gould EasyGraftA240 User's Manual for an explanation of the code.

2. Set the chart for two grid areas by pressing the GRID key until the OVLP and SEP indicators are both lit.
3. Press the SEL key until the TIME indicator lights. The recorder will display the latest time setting. Press the SET key. Observe that the time display blanks and the TIME indicator begins to flash. Use the numerical keypad to set the time to the system time displayed on the angle-time display in the data control assembly. The recorder displays the time as: (hour:minute:seconds). Press the SET key again to store the time setting in memory.

4. Press the SEL key until the DATE indicator lights. The recorder will display the latest date setting. Press the SET key. Observe that the date display blanks and the DATE indicator begins to flash. Use the numerical keypad to set the date to the system date displayed on the angle-time display in the data control assembly. The recorder displays the date as: (month:day:year). Press the SET key again to store the date setting in memory.
5. Press the SEL key until the I.D. indicator lights. The recorder will display the latest I.D. message in the display window. The I.D. message contains one digit, followed by a colon, followed by up to five digits. The first digit is the channel number. The five digits after the colon are the I.D. message.

Press the SET key twice. Use the numeric keypad to enter channel number 1. (Left most digit on display). Numbers 5 through 0 are ignored.

Press SET. The I.D. indicator will flash after channel selection. Use the numeric keypad to enter the station WBAN number. The WBAN number is unique to each station and will identify the station doing the chart recording. You can enter a total of five numbers. Press the SET key to store the number.

NOTE

You must make the channel selection when the recorder is in select mode (i.e. when the I.D. indicator lights steady). You must make the I.D. message entry when the recorder is in set mode (i.e. when the I.D. indicator is flashing).

6. Press the recorder POWER button to turn off the recorder.

DOME

1. DO NOT CONNECT THE RECORDER TO THE R/ACU. Plug the recorder into the AC outlet on the R/ACU. Press the recorder POWER button to apply-AC power to the recorder. The recorder will display the current time in the display window located on the upper left side of the front panel.
2. Set the following switches on both amplifiers.
 - a. Press the X100/X1 button in (X100).
 - b. Position the DC/AC button out (AC coupled).
 - c. Press the RMS/DC button in (RMS).
 - d. Position the FLT button out (filter off).
 - e. Position the OFF/ON button out.
 - f. Set VOLTS FULL SCALE knob to 1.
 - h. Push the VAR GAIN knob in. (VAR GAIN off).
 - g. Check variable offset.

Model 13-66 15-20: Push the VAR OFFSET knob in (Figure 8, circle 7). Check that the “NOT REF” LED (Figure 8, circle 8) is off.

Model 13-6615-20S: (has vernier variable gain control, Figure 8, circle 7) Check that the “NOT REF” LED (Figure 8, circle 8) is off.
3. Press the 5 mm/sec chart speed button. Push the CHANNEL POSITION knobs in. The LEDs for the channel positions will light. Use the inner knobs of each channel to position the traces along the **righthand** edge of each grid area. Press STOP.
4. Press the recorder POWER button to turn off the recorder.

5. Connect the recorder to the ART-1/2 with the 25 ft. interface cable as shown. Connect the single Amphenol connector to the recorder output jack on the front panel of the R/ACU as shown in Figure 9. Connect the two connectors to the recorder signal conditioners. Use the left hand signal conditioner for azimuth and the right hand for elevation. The connectors are labeled “Azimuth” and “Elevation”.

If your system has a shelf on the pedestal, put the recorder on the shelf. Secure the recorder so it will not fall if the antenna moves rapidly. Make sure that the elevation assembly will not hit the recorder when the antenna moves in elevation.

If your system does not have a shelf, place the recorder near the base of the pedestal. Make sure that the antenna will not hit the recorder when it is slewed in either elevation or azimuth. The interface cable is 25 feet long to allow it to wrap around the pedestal during a flight.

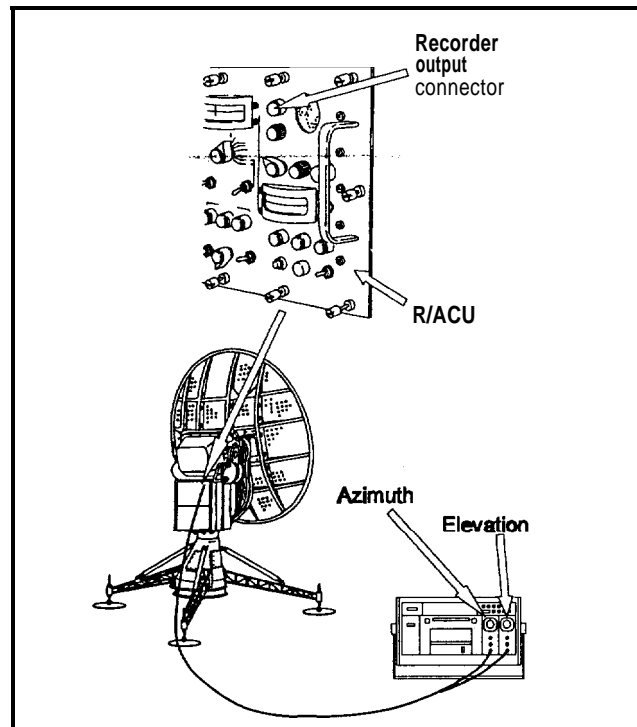


Figure 9

6. Press the recorder POWER button and apply AC power to the recorder.
7. Press the 5 mm/sec chart speed button to start the recorder. With the recorder running, **slowly** slew the ART-1/2 antenna in each axis. Observe that the recorder draws a sinusoidal waveform for each axis in the respective area on the chart. The recorder trace should cover as much of the grid area as possible without waveform flattening at the positive and negative extremes.
8. Turn on annotation by pressing the ANNOT (annotation) key. The recorder will print the chart speed and page number on the left edge of the paper. The channel number, I.D. message, and signal conditioner status will appear on the right side of the channel grid. Press the STOP key on the recorder.

9. Press the EVENT key until the TIMER indicator lights. With annotation enabled, the recorder will print timer marks and the time on every other sheet on the right edge of the paper. For chart speeds of 1 mm/sec or higher, the timing marks print at one second intervals. For chart speeds lower than 1 mm/sec, the timing marks print at one minute intervals. Press the EVENT key until both the EVENT and TIMER indicators light to activate both markings.

The recorder is now ready to record flight data.

At release, press the 5 mm/sec chart speed button to start the recorder.

4.3 Termination - At the end of the radiosonde flight, press the STOP key to stop the recorder.

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CHAPTER V. ANALYSIS OF ANGLE RECORDINGS

5.1 General - The recorder provides an easy method of determining ART tracking system malfunctions by producing a real-time chart recording of in-flight tracking stability. During tracking system adjustments, the chart recording becomes a powerful troubleshooting tool showing the technician the effects of the adjustments. Experience with the recorder will lead to more accurate analyses of ART tracking system malfunctions. Comprehensive reports by technicians of remedial actions taken, along with chart recordings showing the effect of the actions, will provide valuable data for improving the tracking accuracy of the ART 1/2 systems.

To obtain meaningful angle recordings, the recorder and the ART-positioning system components must be in good condition. The ART mechanical parts must be free of binding or drag and all associated control circuits properly aligned. Theoretically without these conditions, a true picture of system performance cannot be obtained.

About 10 minutes after release, or when the rate of change of elevation angles has decreased to approximately 1/4 degree per minute, the synchro position recorder trace should be marked to show the elevation angle on the simulator display and the elapsed time. This will enable the trace to be compared with the printed angle data from the ART system during the analysis of the recording.

Except where noted, all figures show an ART 1/2 system performance running the built-in profile 6 test with the run time set to 20 minutes. All antenna positioning system parameters were aligned in accordance with EHB-9, Section 2.4, ART 1/2 Maintenance Note 10. The values in Maintenance Note 10 are "nominal values" designed for rapid alignment of any ART 1/2 system to support a radiosonde flight.

During the tests, the ART 1/2 system showed improved tracking despite intentional misalignment of certain Maintenance Note 10 "nominal values". This underscores the value of the recorder as an advanced maintenance tool with the capability to precisely align any ART system regardless of slight system variations caused by geographic location and system component age, etc.

System variations may require different adjustment values from those given in Maintenance Note 10. This is normal and accounts for the differences from one ART 1/2 system to another.

As the electronics technicians gain experience with recorder use and more data from the field become available, the Engineering Division may revise the values in Maintenance Note 10.

5.2 Chart Description - With continuous antenna movement the 180: 1 synchro produces a sine wave output on the recorder chart. One sweep across the chart equals one-half degree of antenna movement in the respective axis.

It should be noted that the chart speed in the Figures depicted on pages 23 through 38 are set at 5 mm/sec. The chart speed as well as the Variable gain may be increased to portray magnified trace variations to depict actual system performance.

5.3 Elevation Trace - The quality of the elevation angle trace is a good indicator of system performance. In a normal sounding, the elevation angle changes occur smoothly. A smooth elevation angle trace indicates a properly functioning system while a ragged or irregular trace indicates malfunctioning equipment and calls for corrective action.

5.4 Rapid Angular Change - See figure 5- 1. Angle traces of this type are not suitable for evaluation purposes. Even a system that performs poorly will produce a relatively smooth trace when the elevation angle changes rapidly. Generally whenever angular changes are greater than 2 degrees per minute the trace should be disregarded.

5.5 Slow Angular Change - See figure 5-2. This trace shows an angle change of approximately 1 degree per minute and is of the right order of magnitude for assessing system behavior. However, based on the maximum recommended repeatability error (0.02 degree), the indicated dead zone of 0.1 degree is too large and calls for higher elevation servo gain. Note, even in a system such as this, an elevation servo gain setting higher than optimum would make the system unstable, and the trace would appear ragged or even oscillatory. A small amount of “stepping” (successive discrete changes in elevation angle indication) is tolerable. If the gain control were set to less than the optimum value, the magnitude of the steps would increase. The steps are, in effect, a measure of the system’s dead zone. The angular span connecting successive similar points on the trace is a measure of the dead zone.

5.6 Meteorological Data Interference - The video amplifier card in the R/ACU uses a sample and hold circuit to remove meteorological (MET) data pulses from the tracking error voltage. During the MET data pulse period, a capacitor holds the charged voltage level of the sampled tracking error voltage. The MET data remover circuit passes an essentially intact 30 Hz tracking error signal. Limitations in this circuit will allow the tracking system to oscillate when the MET data pulse repetition rate is 30 per second. The oscillations occur at a typical 10 cycles per minute. The system will experience interference as long as the repetition rate of the MET data pulses is within the “interference bandwidth” of the video amplifier. The interference bandwidth is very narrow, however, reducing the interference would also discriminate against the 30 Hz tracking error signal and degrade ART system performance. For the time being, this shortcoming will have to be tolerated. A higher than optimum setting of elevation servo gain will accentuate the problem.

5.7 Limiting Angles - The antenna will oscillate in elevation in the limiting angle region. As a rule, the period of the limiting angle oscillations is much longer than meteorological pulse interference oscillations. A frequency of oscillation of one per minute is fairly typical.

5.9 Elevation Servo Gain High - Figure 5-3 shows the effects of high elevation servo gain. Note the small sine wave pattern in the circled area of the trace. The sine wave pattern shows that during rapid radiosonde movement the antenna drove past the radiosonde in both directions, overshooting actual radiosonde position. The high elevation servo gain causes overshoot due to excessive antenna inertia developed from the high drive rates. Normally, the mechanical motion damping provided by tachometer feedback would control overshoot. In figure 5-3, elevation servo gain was high enough to overcome tachometer feedback, resulting in overshoot.

When the elevation servo gain is high, the azimuth channel is completely unaffected. If the chart shows that both channels have high servo gain problems, improper system gain may be the cause.

5.10 Elevation Servo Gain Low - Figure 5.4 shows the effects of low elevation servo gain. Note the stepping pattern in the circled area of the trace. The stepping pattern shows that antenna position is lagging the radiosonde position, indicating slow or “sluggish” antenna response to radiosonde positional changes. The horizontal portion of the “step” indicates no antenna movement. The vertical portion of the “step” indicates antenna movement.

When the elevation servo gain is low, the azimuth channel is completely unaffected. If the chart shows that both channels have low servo gain problems, improper system gain may be the cause.

5.11 Azimuth Servo Gain High - Figure 5-5 shows the effects of high azimuth servo gain. Note the ripple in the circled area of the trace. The ripple shows the antenna drove past the radiosonde in both directions, overshooting actual radiosonde position. The high azimuth servo gain causes overshoot due to excessive antenna inertia developed from the high drive rates. Normally, the mechanical motion damping provided by tachometer feedback would control overshoot. In figure 5-5, azimuth servo gain was high enough to overcome tachometer feedback, resulting in overshoot.

When the azimuth servo gain is high, the elevation channel is completely unaffected. If the chart shows that both channels have high servo gain problems, improper system gain may be the cause.

5.12 Azimuth Servo Gain Low - Figure 5-6 shows the effects of low azimuth servo gain. Note the stepping pattern in the circled area of the trace. The stepping pattern shows that antenna position is lagging radiosonde position indicating slow or “sluggish” antenna response to radiosonde positional changes. The horizontal portion of the “step” indicates no antenna movement. The vertical portion of the “step” indicates antenna movement.

Due to greater antenna and pedestal mass, the azimuth channel is inherently more stable than elevation. Sufficiently low azimuth servo gain would produce a trace with stepping similar to the trace in figure 5-4 showing low elevation servo gain. Observe that the elevation channel is completely unaffected. When the chart shows that both channels have low servo gain problems, improper system gain may be the cause.

5.13 Elevation Tachometer Gain High - In the referenced figures, we manually positioned the antenna 2 degrees off the target antenna and allowed the system to automatically track back to the target antenna in near auto. Figure 5-7 shows the effects of high elevation tachometer gain. Note how long it takes for the system to track back to the target antenna.

5.14 Elevation Tachometer Gain Low - Figure 5-8 shows the effects of low elevation tachometer gain. Note how fast the antenna returns to the target antenna. Figure 5-9 shows normal tachometer gain,

5.15 Azimuth Tachometer Gain High - Figure 5- 10 shows the effects of high azimuth tachometer gain. Note how long it takes for the system to track back to the target antenna.

5.16 Azimuth Tachometer Gain Low - Figure 5- 11 shows the effects of low azimuth tachometer gain. Note how fast the antenna returns to the target antenna. Figure

5.17 System Gain High - Figure 5-13 shows the effects of high system gain. Note how the system appears to oscillate in both channels. The system tracking looks generally rough and erratic.

5.18 System Gain Low - Figure 5-14 shows the effects of low system gain. Note the stepping in both channels.

5.19 System Phasing, - Figure 5-15 shows the effects of poor system phasing. System phasing provides the elevation and azimuth directional reference to the ART positioning system. Note the general indication of instability in both channels. Observe that errors in one channel induce errors in the other channel as the antenna attempts to acquire a lock on the radiosonde.

When system phasing is incorrect, the antenna will not drive in the correct direction for any given error signal. Additionally, antenna mass induces a small lag between position error sensing and error correction. As a result, the antenna rotates around the actual radiosonde position but never locks on to the radiosonde.

Figure 5-16 shows normal system phasing. Note that the antenna moved in azimuth with no movement induced in the elevation channel.

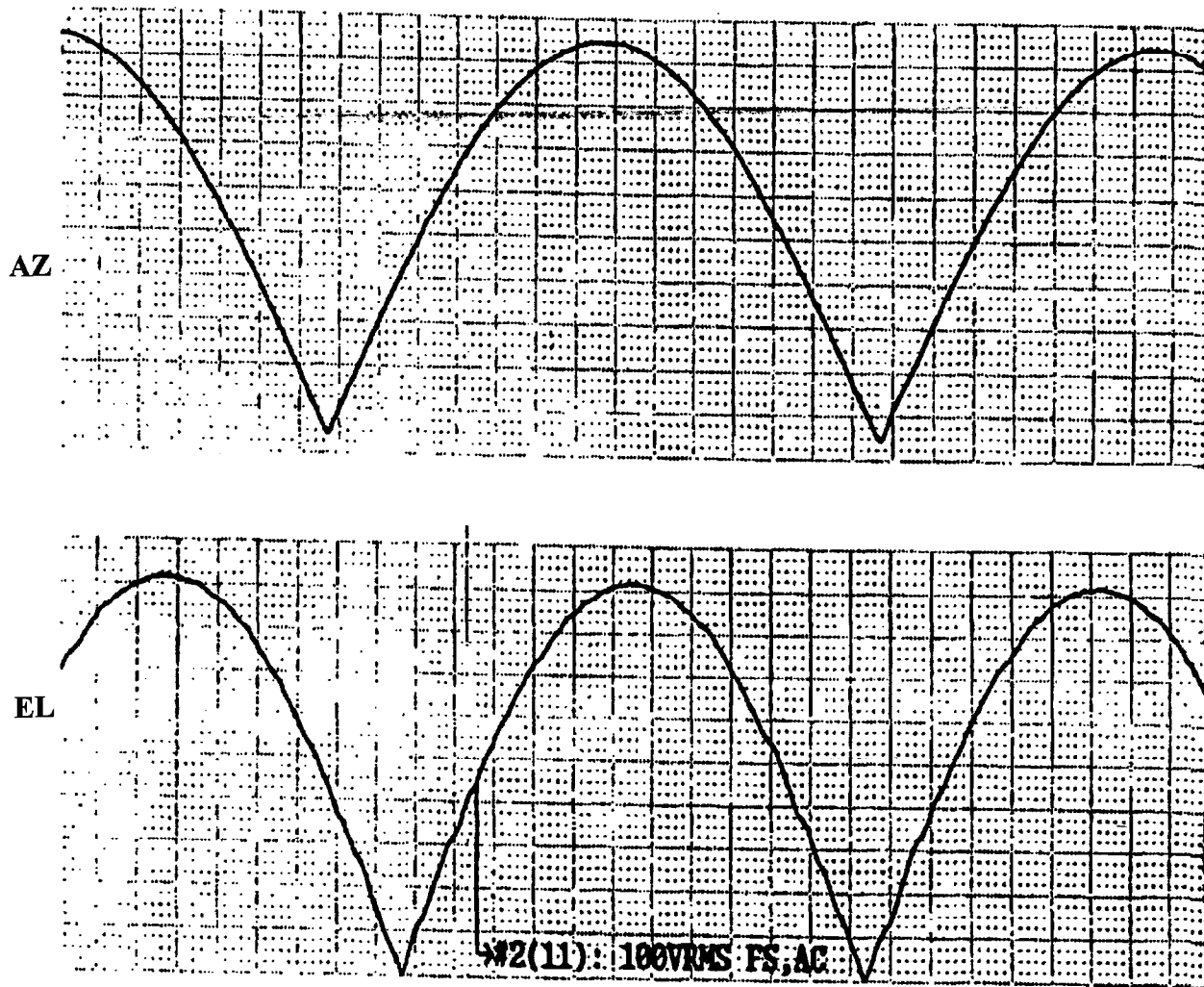


Figure 5-1 Rapid Angular Change

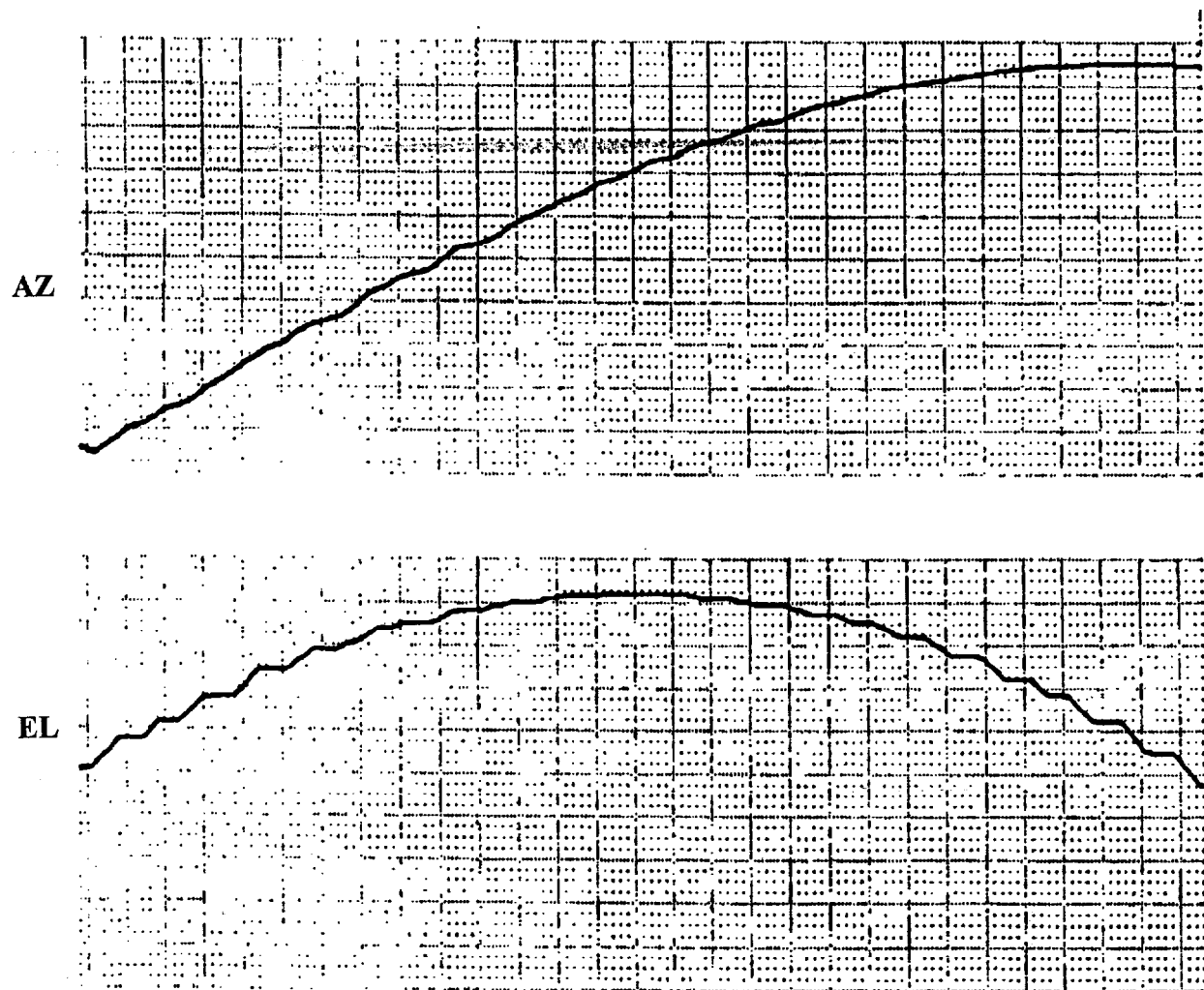


Figure 5-2 Slow Angular Change

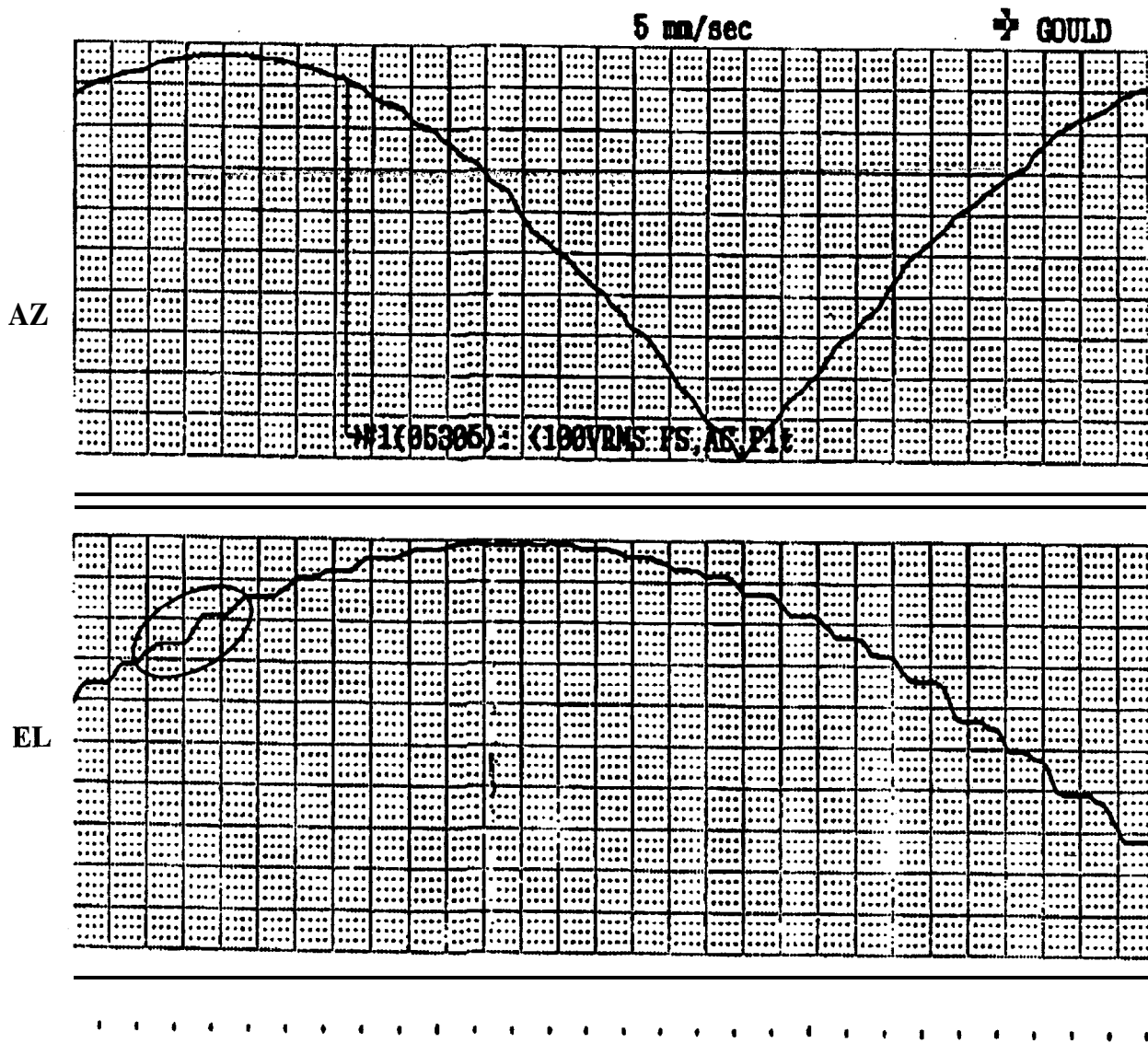


Figure 5-3 Elevation Servo Gain High

100V RMS FS, AC, F1

26

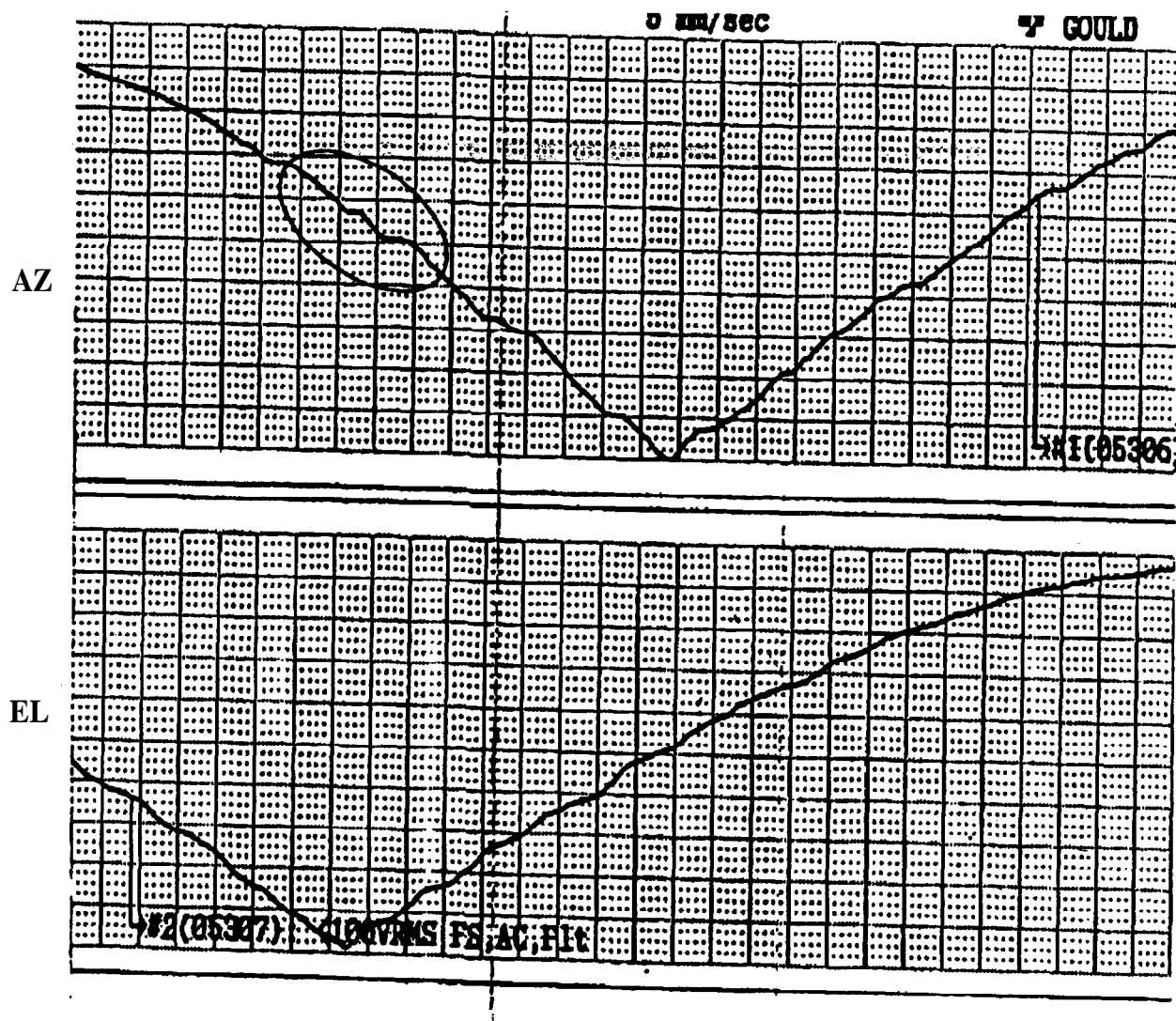


Figure 5-5 Azimuth Servo Gain High

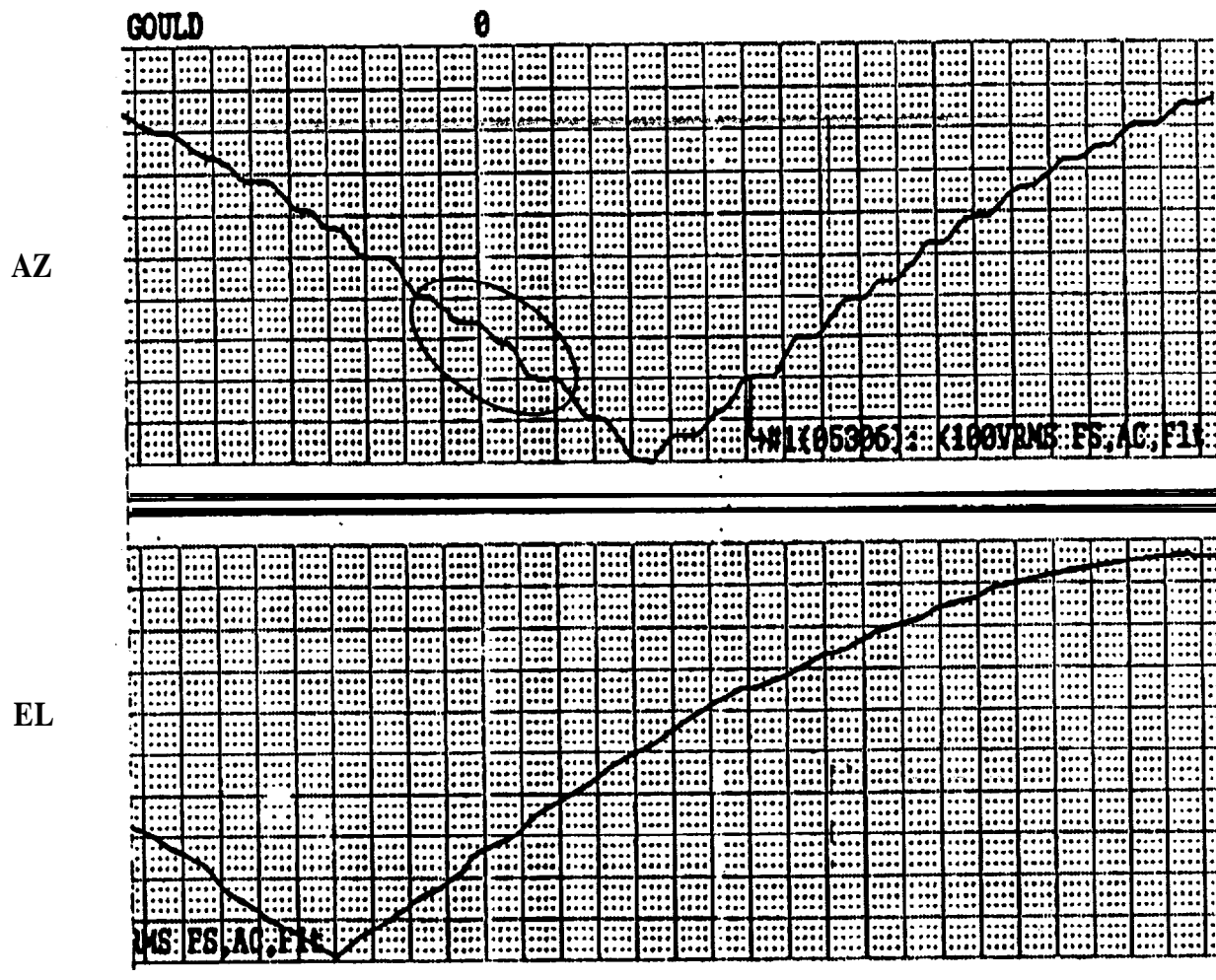


Figure 5-6 Azimuth Servo Gain Low

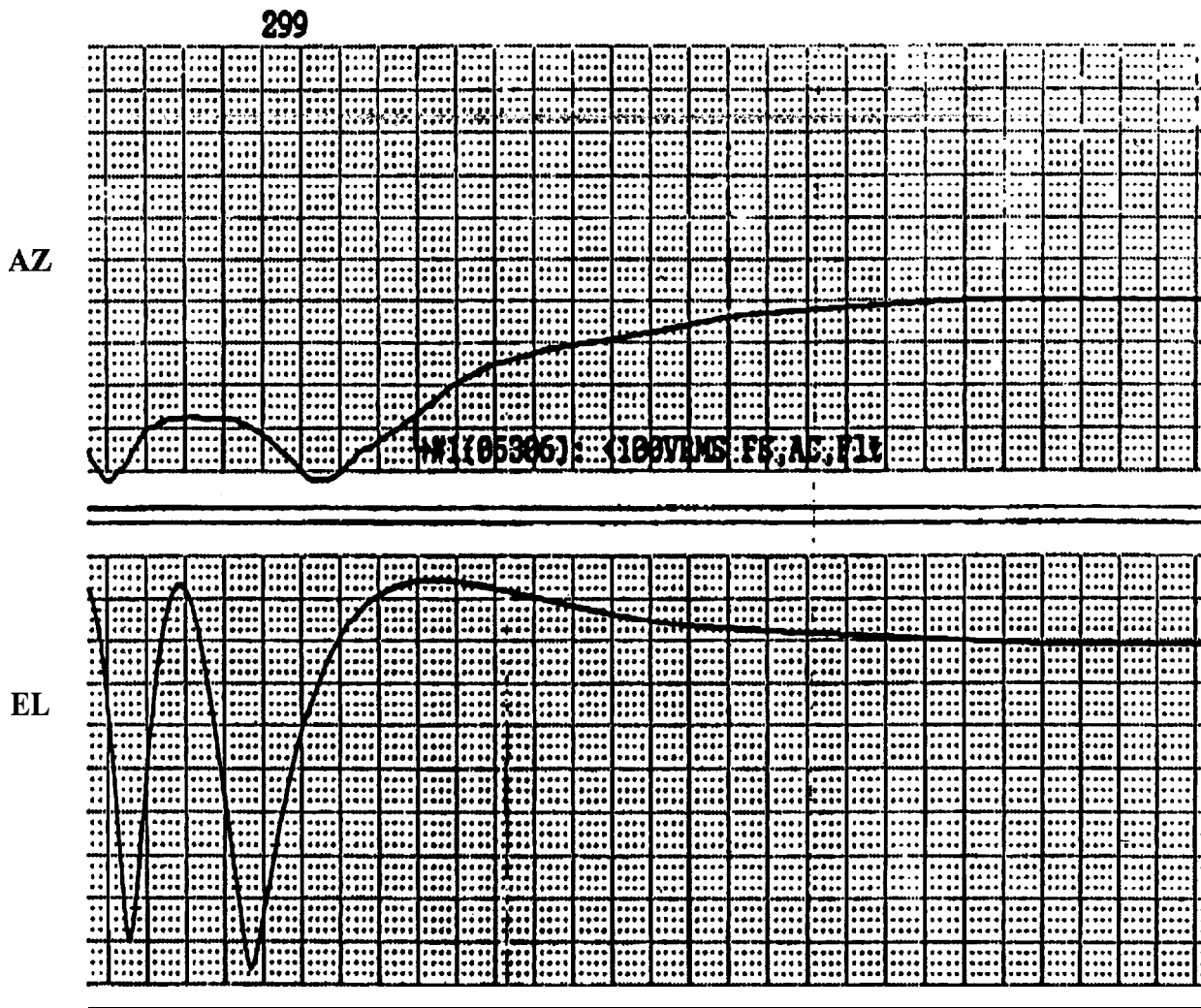


Figure 5-7 Elevation Tachometer Gain High

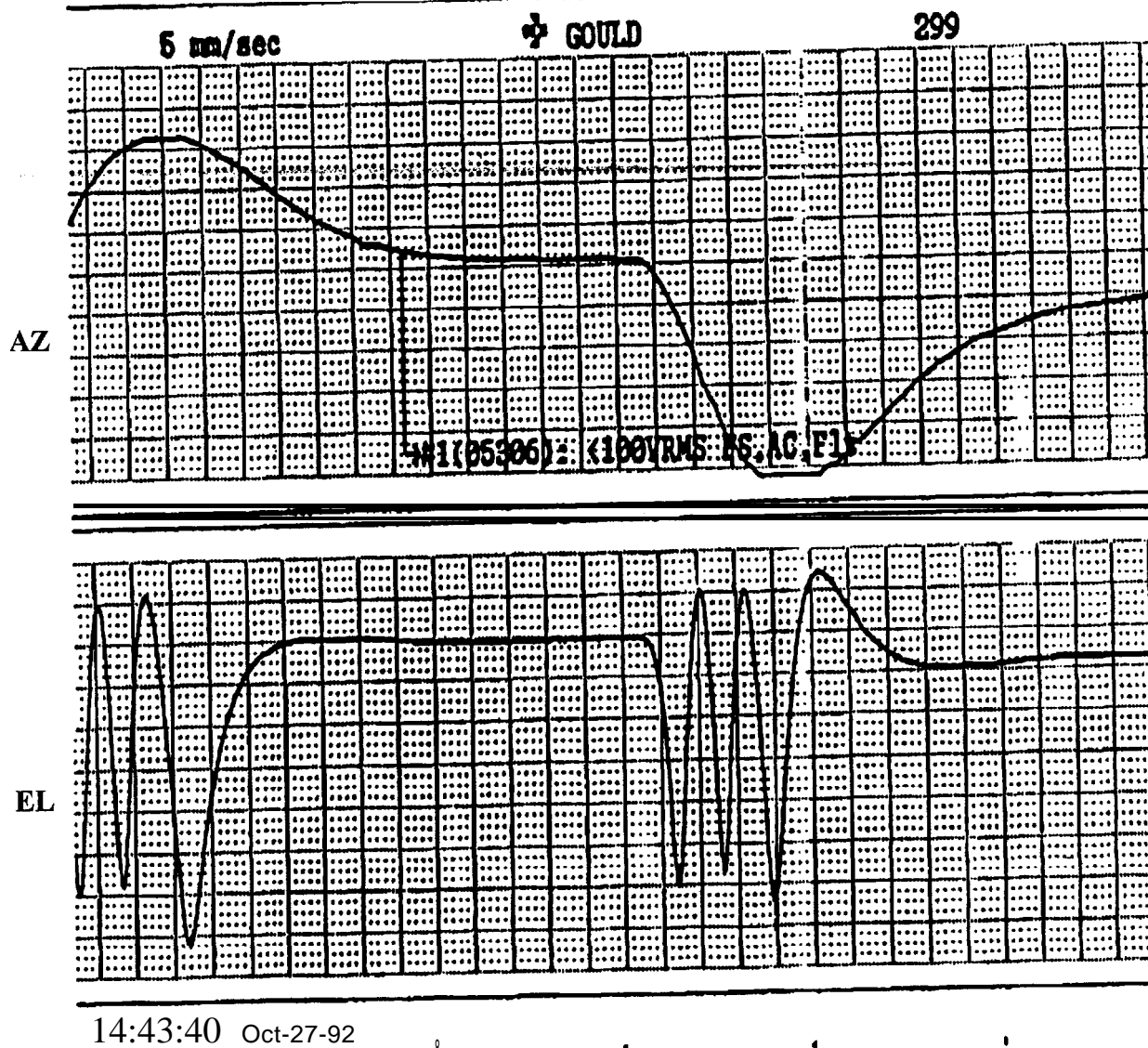
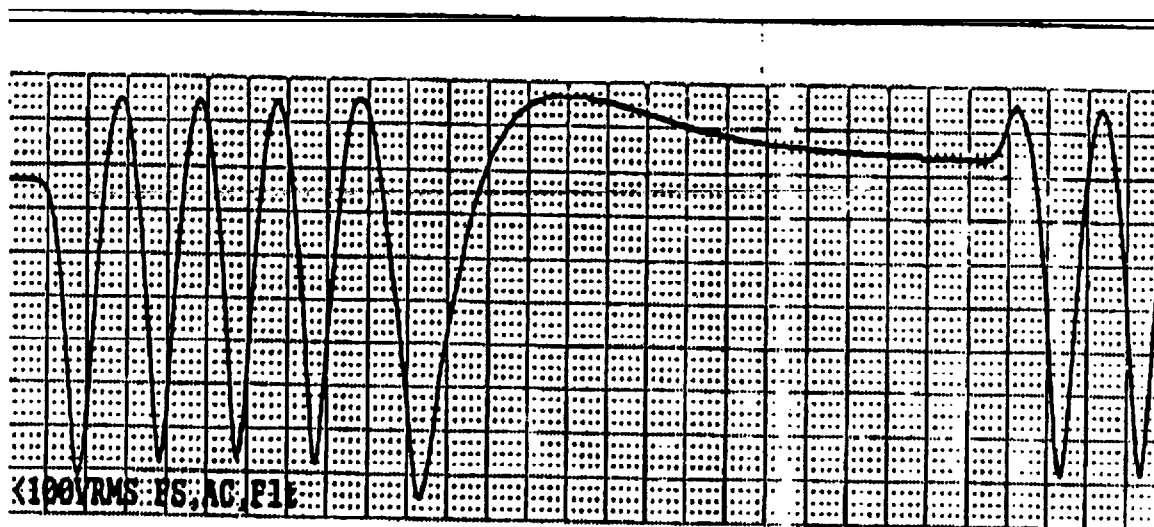


Figure 5-8 Elevation Tachometer Gain Low

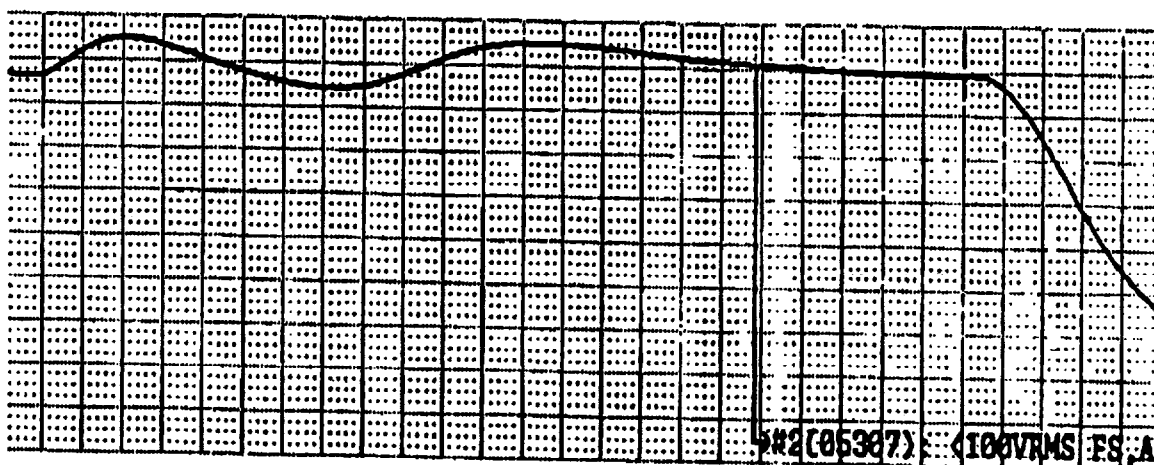


Figure 5-9 Elevation Tachometer Gain Normal

AZ



EL



14:50:07 Oct-27-92

Figure 5-10 Azimuth Tachometer Gain High

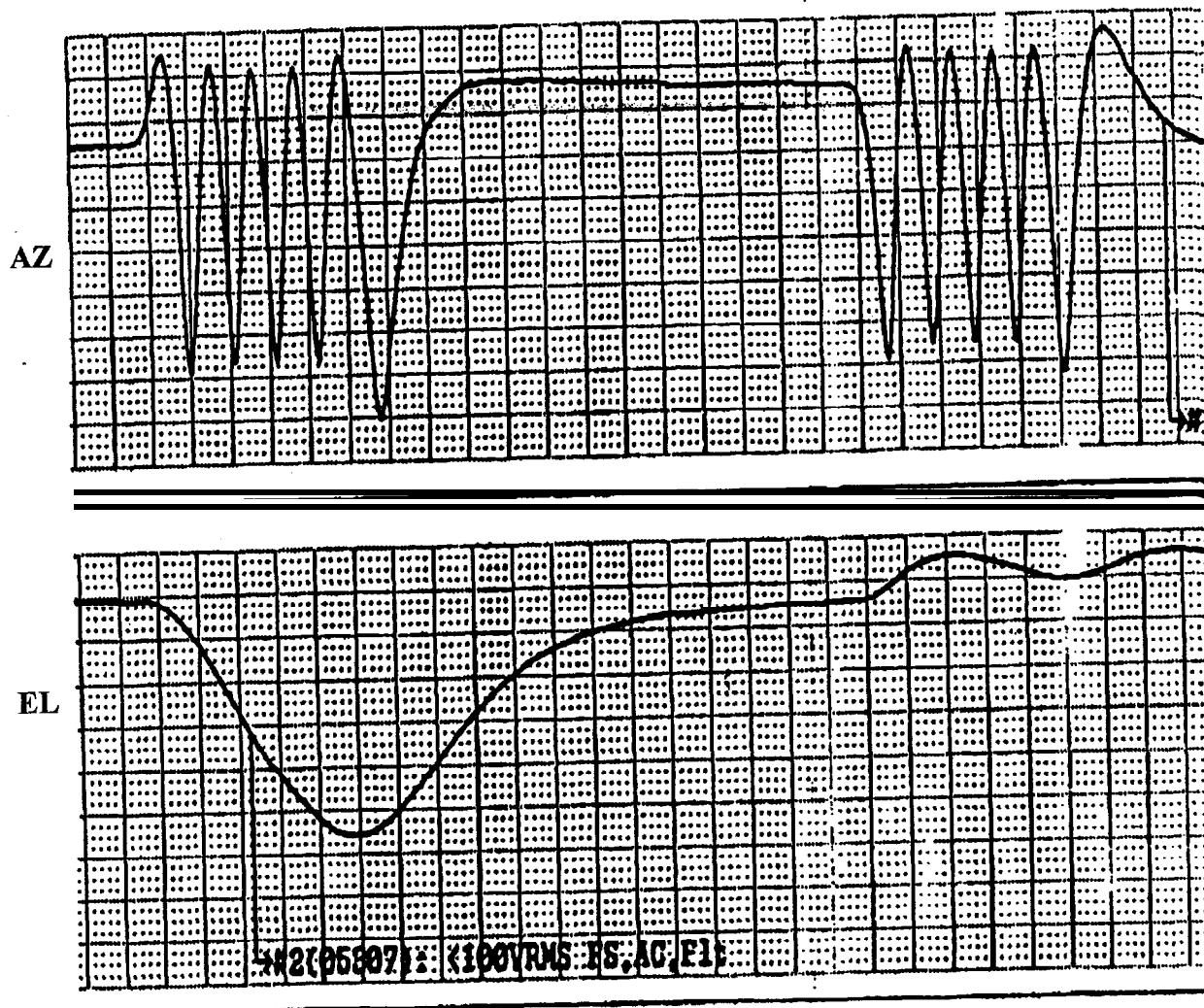


Figure 5-11 Azimuth Tachometer Gain Low

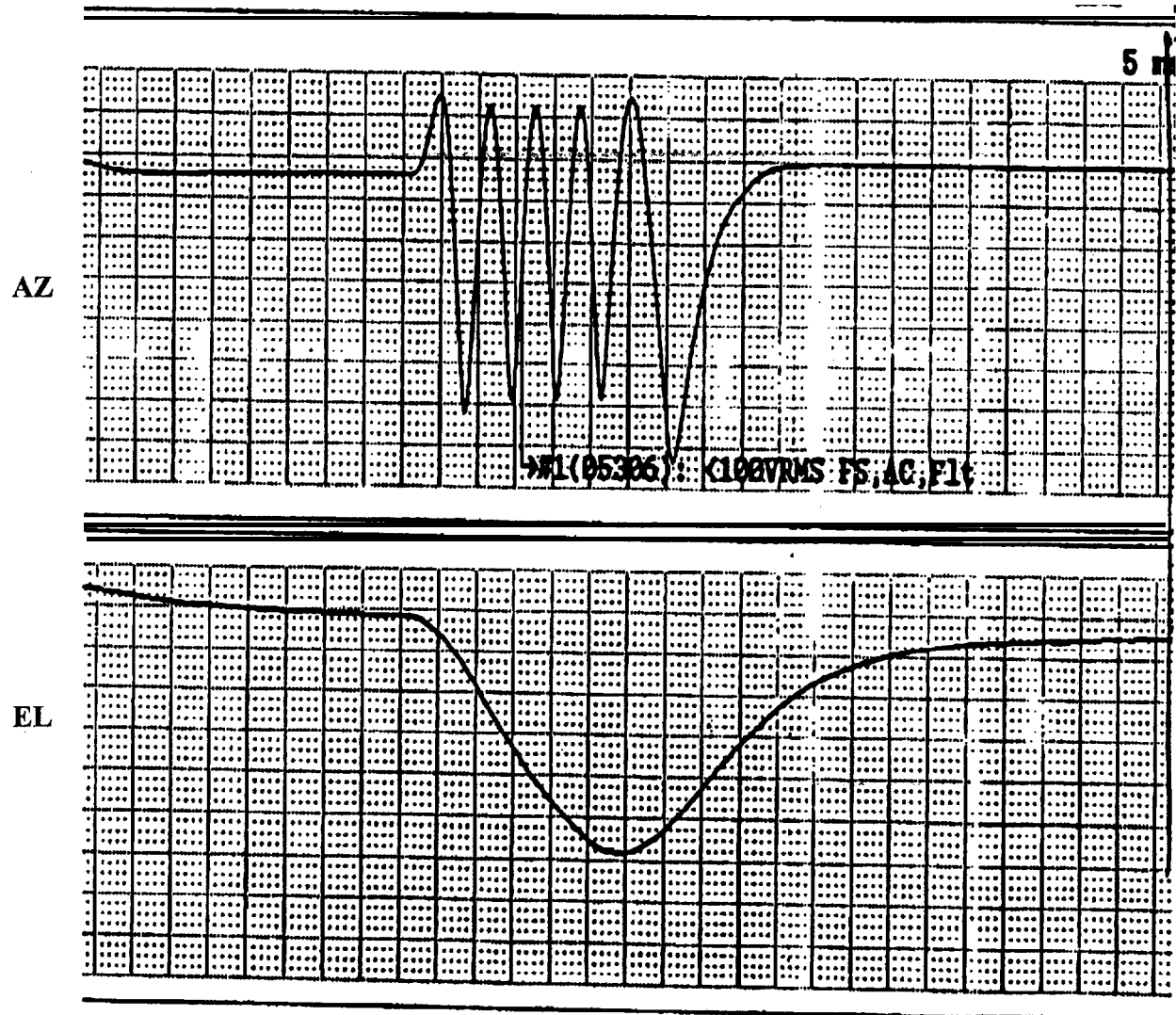


Figure 5-12 Azimuth Tachometer Gain Normal

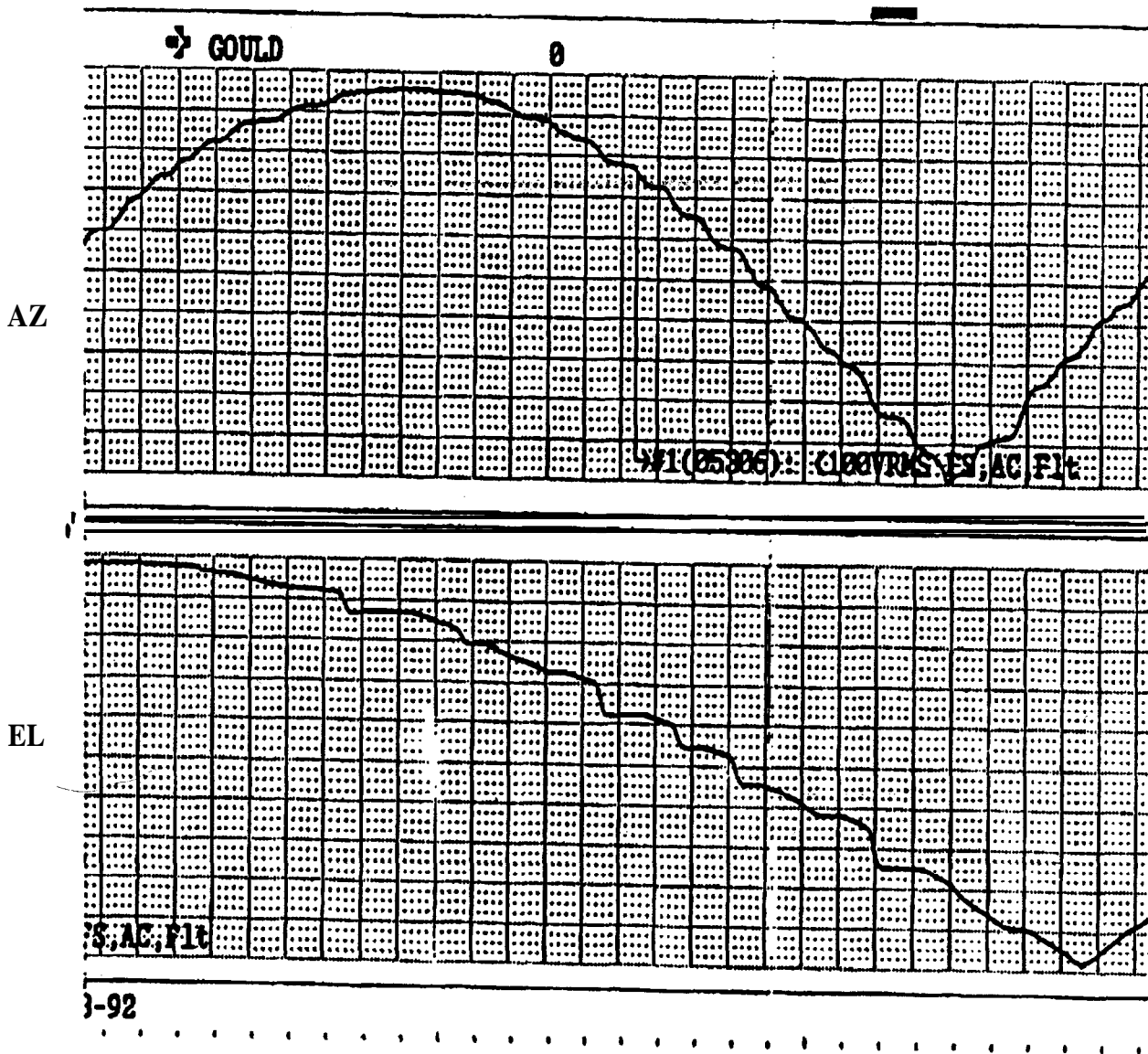
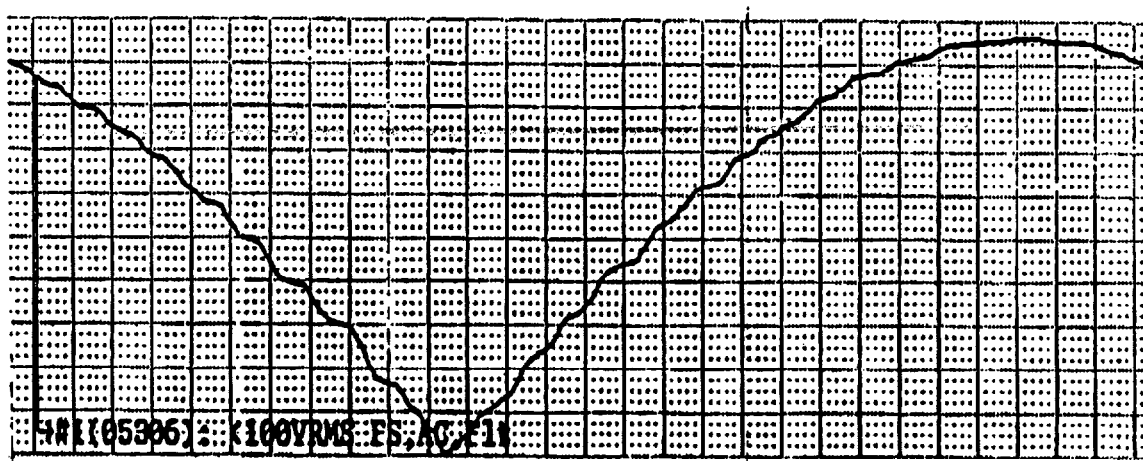


Figure 5-13 System Gain High

AZ



EL

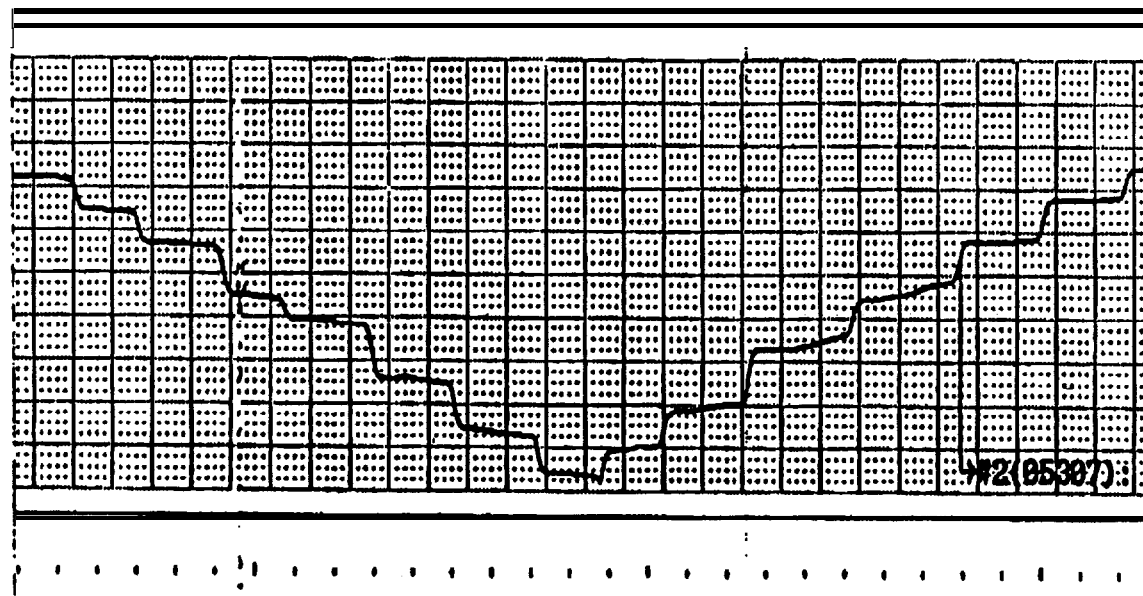


Figure 5-14 System Gain Low

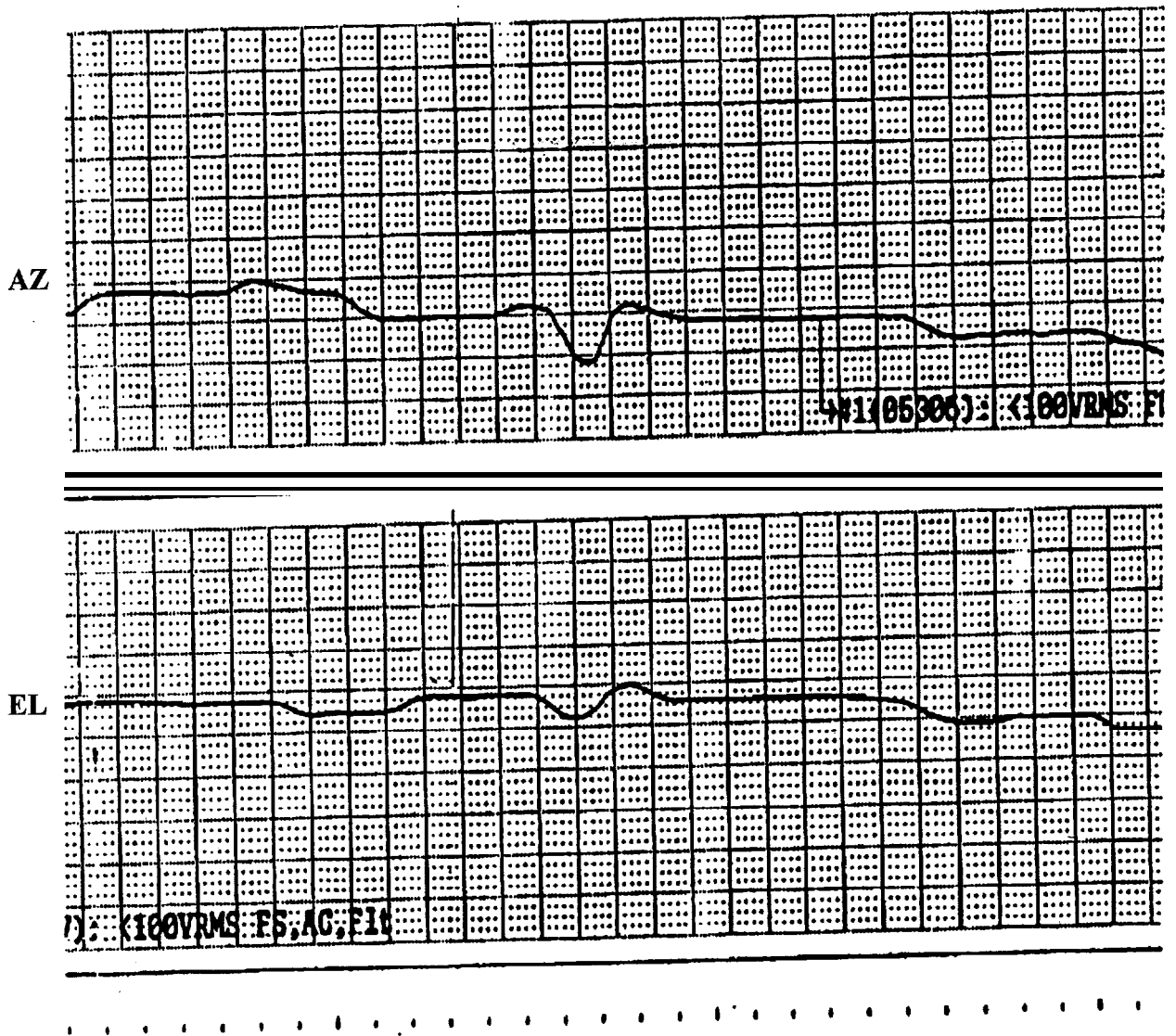


Figure 5-15 Incorrect System Phasing

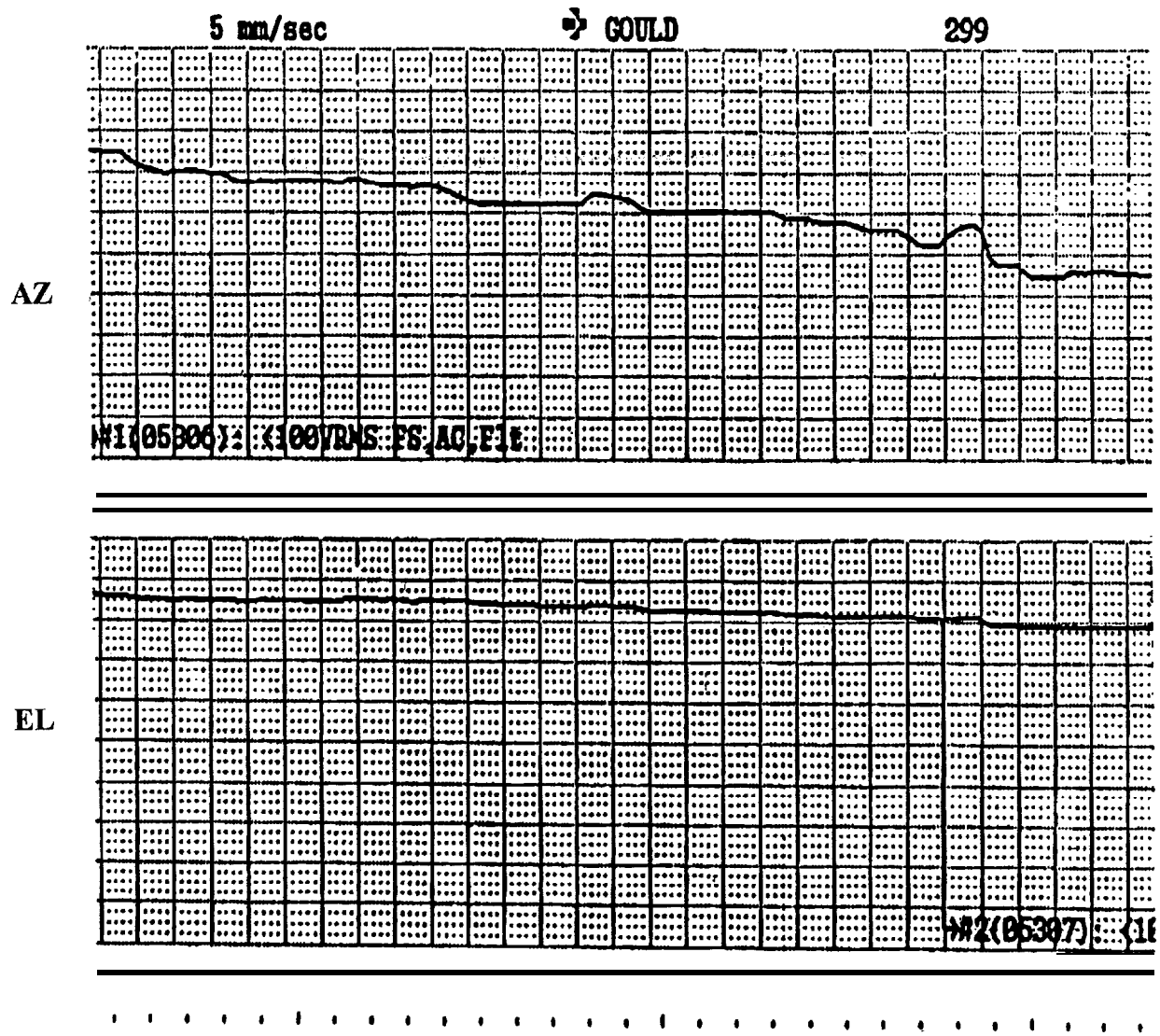
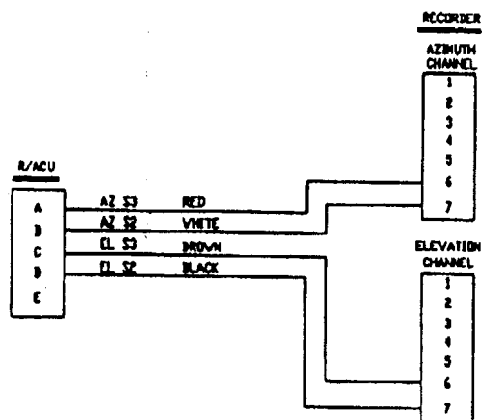
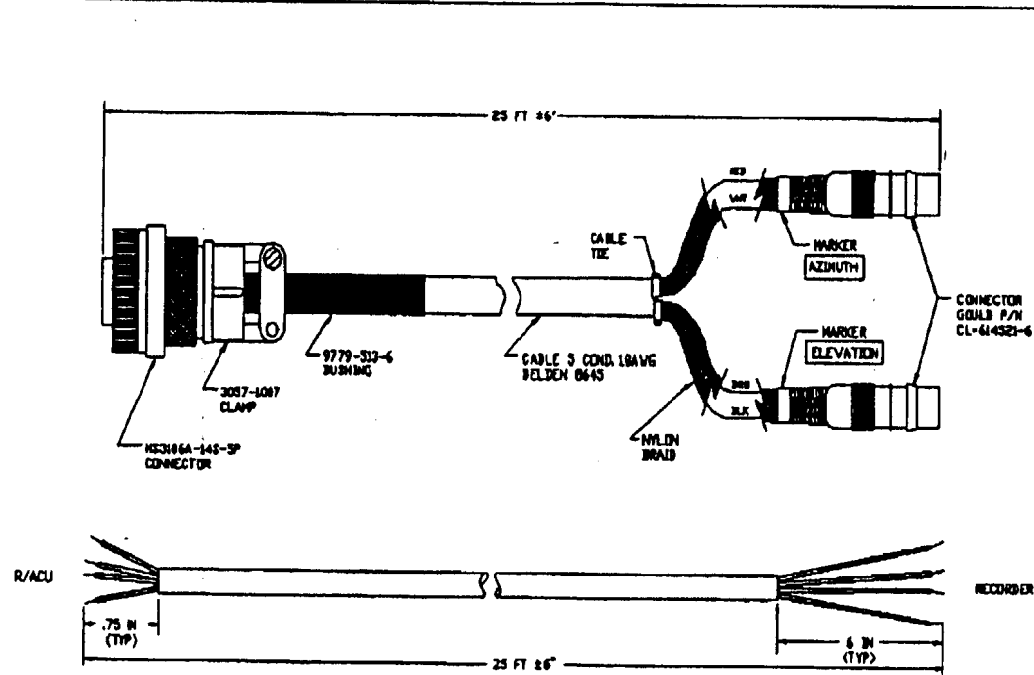


Figure 5-16 Normal System Phasing



REVISIONS				
ZONE	LN	DESCRIPTION	DATE	REV. BY APPR

ENGINEERING DIVISION		U.S. DEPARTMENT OF COMMERCE	
SILVER SPRING, MD. 20910		NATIONAL BUREAU OF STANDARDS ADMINISTRATION	
		ANGLE RECORDER	
		INTERFACE CABLE	
F.L. PETERS		3	7591-VI-10001
		1	10001